

Phillip and in similar places along the rising coast; and also in the selection of places for townships, wharves, and docks; and, lastly, that it is important that our own coast be re-surveyed for the sake of the life and goods in ships approaching it.

ART. II.—*On the Reclamation and Cultivation of Batman's Swamp.* By ALEXANDER KENNEDY SMITH, Esq., C.E., F.R.S.S.A.

[With a Plate.]

[Read before the Institute, May 5th, 1858.]

MR. PRESIDENT AND GENTLEMEN—In preparing this paper upon the reclamation and cultivation of Batman's Swamp, I have endeavoured to make it more a practical digest than a theoretical essay.

Residing upon a portion of the Swamp, and having erected the City Gas Works there, I have had a greater interest in, and a wider field for observation, than those who casually or occasionally visit that locality. The result of these observations is contained in this paper, which I have endeavoured to condense as much as possible, consistent with bringing the evil and its remedy fairly before your notice.

This swamp is situated at the west end of this city, and is bounded by the Murray River and Mount Alexander Railway on the east and north; by the Salt Water River and Footscray on the west; and by the Yarra Yarra on the south. (See Plate.)

All that portion of it that lies north of a line forming the continuation of Victoria-parade, or Victoria-street, running due west to Footscray, has been disposed of by the Government, and the extent of the major and remaining portion, after allowing a margin of three chains in breadth along the Yarra Yarra and the Salt Water River, and also allowing a reserve of 20 acres near the Powder Magazine and Railway Station for docks, is 1030 imperial acres.

The surface of this large plain is lowest in the centre, by an average depth of 10 inches, and has no outlet either to the Yarra Yarra or Salt Water River. This hollow or basin is therefore the receptacle of surface water, and is principally supplied by the Moonee Ponds district.

When a heavy rain falls, this basin is filled, and overflows

into the Yarra and Salt Water Rivers. In the summer time the water is evaporated from this basin, again to be filled by the collected storm water in the rainy season; or if a southerly breeze, a freshet in the Yarra, and a full moon should simultaneously occur, the greater part of the marsh, and in some cases the whole of it, has been overspread with water to a depth of several feet. In November, 1849, a combination of the above circumstances covered the swamp to a depth of 5 feet, and destroyed a considerable quantity of property and goods in the wharf stores, and in the lower levels of Flinders-street west. From marks made at the time of the flood, I find that the average depth of water over the swamp amounted, as said, to five feet.

To reclaim this land from the inroads of the sea or bay, it will be necessary to guard its confines by an embankment to prevent a similar occurrence. This would do, as far as regards reclamation from the waters of the bay, but if used for cultivation, it must also be kept free, by drainage and pumping, from the storm water descending into the basin alluded to.

In the ordinary state of the bay and river there is sufficient fall to drain the basin, and to keep the entire surface of the swamp free from water; and it would only be in the event of having a continued rain, on the one hand, or the rising of the River Yarra, either by floods or the waters in the bay being ponded back, on the other, that arterial drainage by machinery would have to be resorted to.

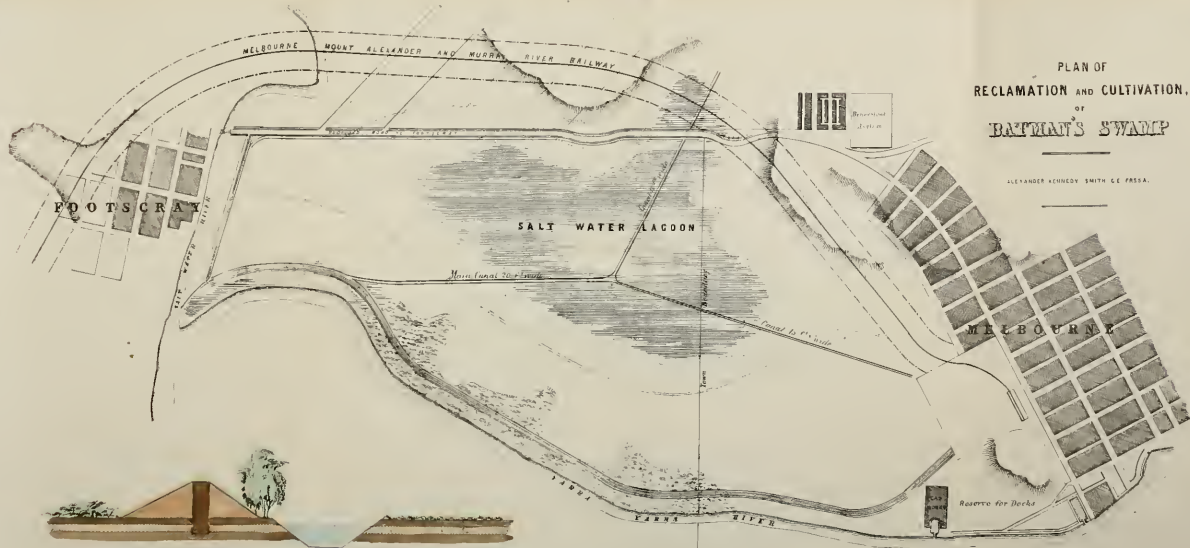
I will therefore advert to—

1st. The method and cost of protecting the swamp from the inroads of the sea, and

2nd. The method of keeping the reclaimed land free from storm water, and the cost of so doing.

Upon measuring the irregular boundary of the entire marsh, as shown on the accompanying plan, I find that it is equal to 460 chains, or $5\frac{3}{4}$ miles, but as an embankment, for reasons to be hereafter given, would only require to be constructed from the railway reserve, opposite the west end of Little Collins-street, round by the Gas Works, the banks of the Yarra, and the Salt Water River, to the punt, it would only measure 250 chains, or $3\frac{1}{8}$ miles.

The soil of the swamp varies from 12 to 26 inches in depth, and is composed of stiff alumina or argillaceous earth, strongly impregnated with salt and gypsum. Immediately beneath this, a stratum of sand, varying from six inches to two feet,



PLAN OF
RECLAMATION AND CULTIVATION,
OF
BATMAN'S SWAMP

ALEXANDER KENNEDY SMITH LE FRERE.

Section of Embankment and Canal

A. L. Stapp Lith. 3/4 x 11 1/2 in. 8" East

occurs ; after this sand is passed, a black retentive clay appears, and continues for at least a depth of 24 feet, but how much further I am unable to say, having only excavated to that depth.

In order to make the whole of the swamp available for cultivation, it will be necessary to embank it on the south and west by an embankment 24 feet wide at the base, and five feet in height, thereby giving a total height of about eight feet above the ordinary level of the Yarra, when the surface level of that river is uninfluenced by unusual causes.

In the formation of this embankment it is necessary, first, to cut a trench three feet in width through the top soil and the underlying stratum of sand, until the stiff retentive clay is reached ; this would be at a depth of about three feet, at an average. The material thus excavated would form part of the embankment above the surface level. After setting off a distance of 13 feet 6 inches on the inner or swamp side of the trench, I propose to excavate a canal 24 feet wide by 5 feet deep, for the threefold purpose of, first, obtaining the material to form the embankment ; secondly, to drain the swamp itself ; and thirdly, that when partially full it may be used as a canal for the transport of manure and produce, in flat-bottomed barges. Care must be taken that the trench first mentioned is filled up with the stiff retentive clay, excavated from the canal, and that a wall of the same description be carried up in the centre of the embankment to its full height.

This embankment in its course intersects some patches of the tea-tree scrub, as shown on the plan, which would necessarily have to be cut down. This scrub, judiciously used, could be incorporated in the bank, so as to prevent the softer material slipping, and also afford considerable protection to the bank itself, in the event of the river rising to an unusual height. The tea-tree scrub, either in the form of fascines or otherwise, would be used on the river side of the embankment only.

By referring to the section of the embankment, it will be seen that to make this, the least costly method is to excavate the material upon the spot, and that its construction thus leaves the canal or drain, or both, fit for their intended purposes, without any extra expense having been undergone for their formation.

I also propose to use the sand excavated (or a portion of it) to dress the top of the embankment, so that in all seasons there would be an excellent footpath from the city to the Salt Water River.

At the present time, a considerable number of the inhabitants of the city go down the river to fish, but owing to the almost impassable state of the small creeks in the scrub, their sport is curtailed, and their pursuit rendered a questionable pleasure.

To make this embankment, main drain, canal, and raised footpath, would only require about £5000, or even less in the present state of the labor market, or about £5 per acre for the reclamation of above 1000 acres.

This expense would have been considerably increased were it not for the possibility of another plan of a road being constructed to Footscray, as a continuation of Victoria and Spencer streets to that rapidly-increasing township, and which I had the honor to suggest to a committee of its inhabitants.

The construction of this road would enable another canal to be cut direct between the Salt Water River and the Moonee Ponds Creek.

As a sum of money will, in all probability, be placed upon the Estimates of 1859 for the construction of this road, it will not be necessary to advert to it more, than by saying that it will protect the swamp on the north from any inundation caused by the rise of the water in the Salt Water River, and that it will shorten the road between Footscray, Geelong, and Melbourne by $3\frac{1}{2}$ miles.

The plan I produce shows the proposed road and the relative position of the places to be benefited thereby.

Having adverted to the method of construction and cost of embankment, I will now proceed to describe the means to be used in keeping the swamp free from surface water, and the cost of doing so.

In the ordinary state of the river, the arterial drains, or small canals shown on the plan, will have a sufficient fall or inclination to keep the marsh sufficiently dry for cultivation. As before described, the side canal from which the embankment is formed, is proposed to be cut to a depth of five feet, that is, an average of three feet beneath the layer of sand before mentioned; this sand, underlying the alluvial soil, will allow the water to percolate through the same, and drain off into the main channel.

This will answer during the dry season, but during the rainy season, or a prevalence of southerly gales, the level of the river would rise so much as to pond the water back upon the surface of the marsh.

In order to prevent this occurring, it would be necessary to have fly valves upon the main outlet; such valves would allow the egress of the water whenever the surface level of the river subsided below a certain point, and would effectually prevent its ingress when rising.

The water, then, with which we have to deal in draining the swamp, is simply that of the rain fall over its own surface, together with that from the higher levels which drain into the swamp and Moonee Ponds.

This could be ascertained by taking the dividing point, commencing at Batman's Hill, and passing along the ridge of the high ground by the Exhibition Building, Parkside, and crossing the Castlemaine road near the University, passing along by the new Cemetery towards Phillipstown, and heading Moonee Ponds creek, returning by Essendon and Flemington. The extent of this watershed I am unable to estimate, even approximately, not knowing the whole locality alluded to; but from observation, I have found that during heavy rain storms, the whole of the water brought down from the Moonee Ponds district has been discharged from the swamp into the Yarra and Salt Water Rivers within the course of a few days, and here it must be borne in mind that this discharge is effected over a wide surface of uneven ground, partly covered with scrub, grass, and other obstructions, and without any regular channel to allow its free discharge.

That the swamp might be successfully cultivated, it would be necessary to guard, as far as possible, against any and every contingency that might arise. With this view, I propose, at the main outlet from the swamp to the river, to have two windmills erected, to work scoop wheels when the level of the river is above the level of the water in the swamp. This would very seldom occur, and the difference of the level caused by the rise and fall of the tide, would allow a great portion of the retained water to flow away by its own gravity at low water.

The constancy of the wind here, as a motive power, is generally admitted, and there are few days in the year without sufficient breeze to work the wheels alluded to.

But here again I would adopt another precautionary measure, viz., to erect a steam engine of sufficient power to lift the maximum amount of water ever known to have fallen upon a given drainage area in this district, in a certain time.

As there are few days in the year when this engine would

be required to work, its maintenance, as a motive power, would be comparatively small. Steam could be got up in about two hours, and whenever the barometer indicated a heavy fall of rain, the fires could be lighted, and the engine be in effective working order as soon as the waters could accumulate and render its assistance necessary; but this would only be required in the event of not having sufficient wind.

The limited height the water would require to be raised, seldom or ever exceeding three feet, would allow an engine of 30-horse power to discharge water, with an average lift of 18 inches, to the amount of 95,000,000 gallons per day, and this without allowing for any variation of tide. If to this we add the work that could be performed by the windmills in question, and also the quantity of water discharged by gravitation, it may fairly be presumed, that under even extraordinary circumstances, that the swamp would be kept as dry, if not more so, than other low-lying lands under successful cultivation.

The cost of erecting machinery for the purpose I have indicated would not exceed the sum before-named (£5,000) for raising the embankment, making a total of £10,000 for the reclamation of, say, 1000 acres of ground, and this adjacent to and partly within the bounds of the metropolis of this colony.

This would amount to £10 an acre on the ground thus reclaimed, and it may be well here to inquire what inducements are held out for this expenditure? There are many, apart from its cultivation, and yet necessarily connected therewith.

In the report of the Local Board of Health for the city of Melbourne, for the year ending December 31st, 1857, it is stated that—

“The position of the present manure depot, and the possibility of its removal to a more isolated locality, have been subjects of serious consideration with the City Council, by whom a committee was appointed to deal with them, but the difficulties have been found so great, as to prevent any action being taken in the matter. The committee have under consideration a scheme for laying a pipe track from the depot, for carrying off the drainage so as to prevent noxious exhalations therefrom, but the expediency or otherwise of putting the plan into operation, of course depends on whether or not any alteration can be advantageously made in the site of the depot.”

Most of you are, I dare say, aware, and certainly our friends from North Melbourne and the University, that the immediate neighborhoods of North Melbourne, Parkside, the University, and the southern confines of the Royal Park, have been a long time, and are at present, polluted by the City Manure Depot. Night-soil and offal are sent out in large quantities from the city to that locality, and there stored in vast heaps and left to give off malaria throughout the neighbourhood, and no effective means have been taken to retain the value of the manure thus deposited by fixing the ammonia with charcoal. On the contrary, the sun, wind, and rain rob it of its fertilizing powers, and a useful and valuable manure becomes a positive and dangerous nuisance. The material stimulants necessary for the proper growth of vegetables and cereals for the support of the animal economy, become, from mismanagement and misapplication, a nursery for the seeds of disease, and are changed to a curse instead of a blessing.

Referring to the last clause of the paragraph before quoted, "Whether or not any alteration can be advantageously made in the site of the depot?" I would suggest the removal of the whole of the offensive material for the purpose of increasing, by proper application, the fertilizing power of the ground thus reclaimed.

You will observe from the plan that I have shown, two main drains or canals, one for carrying down the flood waters of the Moonee Ponds district, and the other from the west end of Little Bourke-street, for the purpose of transporting the fluid sewage of the city, or upon it by a flat-bottom barge, the more solid material and other offal.

By having a depot in the locality, the night-carts could be emptied of their contents into barges prepared for the purpose, and transported by means of these canals to any required portion of the swamp.

This easy means of getting rid of the night soil and other manure in the more immediate neighbourhood of the city, would in itself confer a benefit upon the public at large, inasmuch as the cost of cleanliness would be considerably lessened, whilst any existing nuisance would be turned to a useful and reproductive purpose.

In a previous paper, read by me before this Institute, I suggested the propriety of the Sewerage and Water Commission conveying the whole of the storm water, falling north of La Trobe-street, into the swamp, by means of a tunnel run-

ning underneath the high ground at the west end of the city. The whole of the fresh water discharged by means of this tunnel, during the heavy or prolonged rain falls, would be got rid of in the manner before described, but certain advantages would accrue from its presence under ordinary circumstances, for the better cultivation of the swamp.

The effectual drainage of the swamp would prevent the washing away of the embankment of the Mount Alexander and Murray River Railway. At present these banks are seriously injured during a high wind, by the wash of the water in the swamp, and although a considerable portion of the earthworks of this line, thus exposed to the action of the water in the event of floods, has been changed into a timber viaduct, owing to the unsoundness of the foundation, yet still there are other portions of the same line, the permanency of which would be greatly endangered, if not destroyed, by the recurrence of the floods of 1840 and 1849.

It will thus be perceived that the Government have a direct interest in the reclamation of the swamp for the better protection of their own works.

I may here add, by way of parenthesis, that if at any subsequent period a greater area than I have set aside should be required for docks, the fact of the land being cultivated would in no way interfere with its appropriation for that purpose.

The same motive power applied to the drainage of the land, during storms, could be, with little or no extra cost, used for the purpose of irrigating the soil during the summer months.

That the quality of soil in the swamp is worthy of cultivation, may be generally admitted; that its cultivation, as a sanatory measure, would be of benefit to the public, cannot be denied; but, in order to remove any opinions to the contrary, I may state that I have made some experiments with regard to the capabilities of the soil.

In the latter end of May, 1857, I prepared a piece of ground, by simply ploughing and harrowing, for a crop of Cape barley. This crop did exceedingly well, and the major part of it gave, after being cut, an after-growth equal to the first crop. No manure of any kind was used.

In the month of December last I had the same ground dug over with the spade, into which I transplanted some orange globe mangold-wurzel, and this at the hottest part of the whole summer. The plants took the ground kindly, and have produced roots of which those now exhibited are specimens, weighing, in some instances, 7lbs. each.